Do We Hold Monetary Representations of Environmental Improvements?

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Robin Gregory, Sarah Lichtenstein, and Paul Slovic
Decision Research
Eugene, Oregon

Thomas Brown and George Peterson
Rocky Mountain Forest and Range Experiment Station
Fort Collins, Colorado

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ABSTRACT

Several hundred subjects were asked to value twelve environmental goods, using a response mode that expressed willingness to pay as a multiplier or divider of a purported "budgetary unit." Five groups used different budgetary units (ranging from $1 to $20). Willingness to pay was found to be highly dependent on the size of the budgetary unit. Rejecting possible interpretations based on anchoring and adjustment strategies or laziness, we interpret the results as showing that people's values for such goods are only vaguely related to money: within a broad range, any dollar amount is considered to be an equally accurate expression of value. This poses a severe challenge to those who wish to use contingent-valuation techniques to develop specific monetary values for environmental resources.

1.0 INTRODUCTION

Economic theory defines the worth of an item as the maximum amount that an individual will pay for it or the minimum payment acceptable to relinquish it. The worth to society of a proposed marginal change in a good is therefore the sum of all relevant individuals' willingness to pay or willingness to accept values. When markets for goods exist they adequately establish economic worth for marginal changes in an item, depending on the strength of errors introduced by market imperfections and the like. When actual markets for goods do not exist, hypothetical markets can be created; individuals then can be asked the amount of money they would be willing to spend for an item if a market were created.

This is the basis of the contingent valuation (CV) approach, which has been used by economists to value public goods for about thirty years. The history of the method has been documented in several recent reviews, including those by Cummings, Brookshire, and Schulze (1986) and by Mitchell and Carson (1989). Environmental amenities--such as recreational fishing, hiking, and habitat preservation--have received particular attention because they are highly valued by society but are not usually sold through markets (Bromley, 1986). CV techniques now are widely used to value a diverse group of environmental goods whose quantity or quality might be affected by the decisions of a public agency or private developer.

The validity of CV results, however, is a subject of much controversy. Early discussions of response validity and accuracy focused on the importance of judgmental biases

(e.g., Schulze, d'Arge, & Brookshire, 1981). One prominent source of bias investigated by CV researchers is the so-called "anchoring and adjustment" bias: individuals in contingent markets who start off with a low initial reference point or bid provide lower final value estimates than do participants who start off with a high initial reference amount (Boyle, Bishop, & Welsh, 1985). Other possible sources of bias stem from strategic behavior on the part of respondents or from measurement and sampling errors that may affect the validity of CV results.

In their influential 1986 review of CV methods, Cummings, Brookshire, and Schulze developed the concept of a Reference Level of Accuracy equal to +/- 50 percent; that is, they conclude that a carefully conducted CV study should in most cases yield results that are within 50% of the "true" value of the resource. More recent discussions of response validity include both generally optimistic results (e.g., Loomis, 1990; Kealy, Montgomery, & Dovidio, 1990) and disturbing findings concerning the economic basis for interpreting CV results (Kahneman & Knetsch, 1992), the ability of willingness to pay approaches to reflect the multidimensional attributes of public goods (Gregory, Lichtenstein, & MacGregor, 1992), and the importance of the judgment context (Brown & Slovic, 1988).

In this paper we describe an experiment on the sensitivity of contingent valuation approaches to a specific systematic variation in the response mode. This manipulation provides a further test of the contextual sensitivity of dollar value estimates. It also provides information about a more profound question: Are values for nonmarket environmental goods readily expressed in dollar terms or are they, as we suspect, often strongly held but not readily monetized?

Our motivation for this study rests on a belief that, although people have strong feelings and strongly held values for many environmental amenities that are not sold through markets (Brown, 1984), these typically are not quantified by the respondents in monetary terms. CV methods have the potential to be useful for helping people to express their strongly-held values in monetary terms. However, because people are not used to thinking about environmental amenities in terms of monetary value, the dollar expressions of value may be quite sensitive to the specific procedures used as part of the CV elicitation.

One example of the absence of a monetary representation for values comes from a study by Slovic, Lichtenstein, and Fischhoff (1979) that asked participants to assign a monetary loss to the seriousness of a death from a specified cause, such as cancer or alcoholism. Respondents were asked to compare a death from each cause to a standard unit of loss to society. In one condition this standard loss was $10,000; in a second condition, with a different respondent group, the standard loss was $1,000,000. Participants were asked to provide a multiplying or dividing factor to indicate the magnitude of the monetary value of the specific death by comparing it to the standard.

Not all deaths, ranging from deaths due to smoking or alcohol to deaths from pesticides, were judged to be equally serious. The two groups agreed on the *relative* seriousness of the causes of death: across all 34 items tested, the correlation between the means in the two conditions was .94. The surprising finding was that the mean ratios for any one cause of death were nearly identical in the two groups despite the 100-fold difference in the standard of comparison. One likely interpretation of these results is that the seriousness of deaths from specified causes was represented ordinally in respondents' minds

(as shown by the high correlation) but was not represented monetarily (as shown by the identical ratios).

This viewpoint emphasizes the constructive nature of preferences (Tversky, Sattath, & Slovic, 1988) and the context dependency of CV results (Brown & Slovic, 1988). It suggests that studies of reference accuracy (e.g., +/- 50% deviation from a true value) and bias (i.e., systematic distortions from a "true" value) obscure a more fundamental problem: For many types of environmental resources, particularly those that may be unfamiliar or have not previously been the subject of trades, stable economic values may not exist. Instead, they are constructed at the time of the elicitation. If so, even minor changes in the elicitation process (Payne, Bettman, & Johnson, 1992) could produce large changes in expressed value. In the absence of a strong normative basis there may be scant grounds for selecting a preferred contextual setting for any given resource evaluation situation. Thus, although monetary values for specific environmental resources may show a consistent ordinal ranking, our hypothesis is that dollar measures elicited using conventional CV techniques are unlikely to provide adequate cardinal measures of resource value (Gregory, Lichtenstein, & Slovic, in press).

2.0 METHOD

2.1 Subjects

The subjects were 425 people who responded to advertisements, placed in the University of Oregon student newspaper, seeking participants for several different paper-and-pencil judgment tasks. They were paid $8.00 for the 90-minute session.

2.2 Stimuli

All participants in the experiment were asked about the dollar amount they would be willing to spend, each year, for twelve "proposed environmental projects." These 12 items are shown in Table 1. The items were selected to be familiar ones for which most subjects would be willing to pay a moderate amount.

Insert Table 1 about here

2.3 Design

Each participant completed a six-page questionnaire consisting of instructions (shown in Appendix A), the twelve different "proposed environmental projects," and a five-item computational test.

Subjects were asked how much they would be willing to spend each year, as part of taxes and other payments made to the state of Oregon, to undertake each of the twelve activities. Further, subjects were told to consider the projects separately and one at a time (i.e., as if only that one project were under consideration) and to assume that other people would pay the same amount as part of their state payments.

There were five different versions of the questionnaire. Each used the concept of a "Budgetary Unit" to introduce a standard of comparison without any hint or implication that the standard related in any way to the value of the project, as the more usual "Would you pay *x*?" might. The versions differed in the magnitude of the budgetary unit (BU) that

subjects were told was "used by state legislators to plan out yearly expenditures and to decide among competing projects." The five budgetary units were $1, $2, $5, $10, and $20.

In each version, the twelve environmental improvement activities were presented alongside four expenditure options, shown in columns. For each item, subjects were asked to choose whether they were "not willing to pay anything at all" for the activity in question (first column) or whether they were willing to pay less than one budgetary unit (second column), an amount equal to one budgetary unit (third column), or more that one budgetary unit (fourth column). If the first or third column was selected, subjects were asked to make a check mark. If the second or fourth column (less or more than one BU) was selected, subjects were asked to indicate their willingness to pay by writing down a factor by which the budgetary unit should be divided or multiplied, respectively.

The questionnaire ended with a five-question test that served as a check on respondents' computational abilities (i.e., "What response should you give if your willingness to pay for a proposed project is . . . "). There were five forms of the test, which corresponded to the five different budgetary units. Each of the five sets of test questions included one question for which the correct answer was equal to the standard, one question requiring an integer answer less than the standard, two questions requiring an integer answer greater than the standard, and one question requiring a non-integer answer less than the standard. Subjects who failed this computational test were excluded from the study.

3.0 RESULTS

Our criterion for excluding participants was quite cautious: an individual was excluded unless at least four of the five test questions were answered correctly. About one-third of those participating in each of the five conditions failed to pass the test. Final sample sizes for the five conditions ($1, $2, $5, $10, $20) were 46, 60, 60, 49, and 61, for a total of 276 subjects (i.e., 65% of the 425 original participants).

The results are presented in Table 2, which shows the median willingness to pay, in dollars, by item and by condition. The values in Table 2 have been translated from the raw responses to dollars (for example, a response of "multiply by 2" has been translated to $2 for BU = $1 and to $40 for BU = $20). The results shown in Table 2 therefore permit a direct comparison of the reported willingness to pay for the five different groups.

Insert Table 2 about here

Median responses to three of the items (#9, 10, 11) are identical to the assigned budgetary units for all five groups. For three additional items (#5, 8, 12), responses increase monotonically across the five budgetary units. Thus for 6 of the 11 test items, monetary responses increase with the magnitude of the budgetary unit. Items 2 and 3 fail to show substantial variation across payment methods. Median willingness-to-pay levels for items 4, 6, and 7 exhibit a steady increase across budgetary units up to $10 but then collapse when the budgetary unit is raised to $20.

The remaining item, planting daffodils (#1), was deemed worthless, or nearly so, by most subjects. Across all forms, 57% were not willing to pay anything at all and an additional 15% were willing to pay some amount less than $1.00. The results for this item indicate that subjects discriminated between the items and approached the valuation task seriously. However, because of the large number of zero responses, this item did not provide a clear test of differences between the forms. Further analyses exclude this item.

The complete distributions of subjects' responses are shown in Figure 1; each histogram gives the willingness to pay distributions across all eleven items (excluding Item 1) for one of the five budgetary units. The overwhelming popularity of the budgetary unit is apparent. Over all individual responses to the eleven items, about one-third (33.6%) were equal to the budgetary unit.

Insert Figure 1 about here

The significance of the differences shown in Table 2 was tested using a median test[1] on every pair of medians, for each item separately (excluding Item 1). The results are shown at the top of Table 3.

Insert Table 3 about here

One would expect, when making 110 significance tests, that a few would appear significant by chance alone. Moreover, the data tested here are interdependent: Any one

item appears in 10 tests; any particular response appears in 4 tests; any one subject is included in 44 tests. Such interdependence has an unknown effect on the significance tests.

Rather than correcting for the unknown effects of chance and interdependence by choosing a more conservative level of significance, we explored the robustness of our results by performing the same 110 median tests on the untranslated data, that is, the raw responses as given by the subjects. Thus a response of "half a budgetary unit" was taken as ".5" for all groups (rather than translating it to, e.g., $.50 when BU = $1 and $2.50 for BU = $5). The results of these tests are shown in the lower half of Table 3.

Whereas the null hypothesis for the first set of tests is that the willingness to pay does not differ with a change in budgetary unit, the null hypothesis for these new tests is that the subjects give the same literal response regardless of the budgetary unit (and thus their willingness to pay changes radically).

Whatever the effects of chance and interdependence upon the first set of 110 tests, such effects could be expected to be about the same in this new set of tests. A comparison of the two thus will indicate the robustness of the results. The difference between the two sets of tests is striking. For the translated data, 65% of all tests were significant; 31% were highly significant (i.e., $p \leq .001$). For the untranslated data, 21% were significant; only one was highly significant (i.e., $p \leq .001$).

In 12 of the 110 comparisons, significance was found for both the translated data and the raw data. This does not necessarily mean that one or the other test result was due to chance. It is possible that both sets of data are genuinely different—subjects could give different responses to two forms but fail to make these differences as large as would be

required to equate the translated willingness to pay. The best example of this is Item 12 (planting 100,000 trees), where the median raw response to BU = $1 was "multiply the budgetary unit by 5;" for BU = $20 the median raw response was "equal to the budgetary unit." The joint median for these two groups was "multiply the budgetary unit by 2." As shown in Table 4, BU = $1 elicited much larger raw responses than did BU = $20. However, the five-fold greater response did not match the twenty-fold difference in the size of the budgetary unit. So when the responses were translated into willingness to pay, respondents given BU = $1 seemed willing to pay far less than BU = $20 respondents.

Insert Table 4 about here

There is still no way of knowing how much noise has been introduced into both sets of tests from chance factors and interdependence among the data. However, the stark difference between the two sets of tests (which are both vulnerable to such noise) indicates that the use of different "budgetary units" led to real and wide-spread differences in willingness to pay. The ±50% standard proposed by Cummings et al. (1986) is generally violated by these data.

4.0 DISCUSSION

We are not recommending a "budgetary unit" technique for eliciting willingness to pay values; it is a difficult task, as evidenced by the 35 percent of our subjects who failed the test at the end. Instead, we are asserting that if people held reasonably precise (within ±

50%) monetary values for environmental improvements like these (none of which were novel, strange, or unfamiliar to our subjects), the people who were not defeated by our technique would express such values when asked. The resulting medians would not, then, show any systematic effect across the forms: the translated median dollar responses would be the same across the five groups for any one item. That is, if an environmental good has a stable, well-defined monetary value of $4, then subjects presented with a BU of $2 would multiply this standard by 2 whereas subjects given a BU of $10 would divide this value by 2.5.

However, these data (as shown in Table 2) strongly show a systematic effect of the change in budgetary unit across forms. Together with the strong popularity of the budgetary unit as a response, these results suggest that people have no clear monetary value for these goods. Instead, subjects' responses are sensitive to the arbitrarily assigned change in budgetary units because they can translate their values into money only very roughly. For some items, any amount between $1 and $20 is judged to be as good a translation of value into money as any other amount.

We began this experiment with the hypothesis that people do not hold monetary values for many environmental goods, even for the familiar types of goods used as stimuli in this study. Our data have led to a refinement in our thinking: People do have a sense of their monetary value for these items (as shown most clearly by the differences in responses to Items 1 and 12) but the value is diffuse, spread out across a surprisingly broad range.

The results suggest an unusual interpretation of the term *value*. We do not observe evidence supporting the concept of a "true" value, characterized by a point estimate, for

these environmental goods. Instead, we observe results that support the concept of a broad range, such that *any value within this range is equally likely to be deemed appropriate.* The popularity of the arbitrary budgetary unit suggests that many participants will select it as an appropriate value if it is within this broad range; their concept of monetary value is sufficiently imprecise that the budgetary unit cannot be improved upon.

Several alternative explanations of these data are possible. One explanation is in terms of the anchoring-and-adjustment heuristic whereby respondents, when asked for a numerical judgment, start with any convenient number (even a notably irrelevant number; see Tversky & Kahneman, 1974) and adjust it upwards or downwards. Inadequate adjustment leads such judgments to be unduly influenced by the anchor.

The anchoring-and-adjustment strategy, if used in this experiment, would lead to a systematic dependence of the medians on the budgetary units, yielding a pattern of results somewhat like ours. However, the details of our data do not support an explanation via anchoring and adjustment. As shown in Figure 1, a response equal to the budgetary unit was common; if this is anchoring, it is certainly not adjustment. Anchoring without adjustment is not a strategy one would expect from people who have a clear monetary value for the good.

One further possible explanation of the results is laziness. The experiment was clearly hypothetical; perhaps subjects just didn't bother to think very hard.

The explanation of extreme laziness may be rejected. Subjects obviously spotted the one item most of them found worthless (#1—daffodils) and responded accordingly. At the other extreme, subjects given BU = $1 or BU = $2 took the trouble to indicate that their

value for Item 12 (100,000 trees) was greater than $1 or $2; 69 percent of their responses exceeded the budgetary unit.

The hardest response to make in this task is to report a non-zero value less than the budgetary unit. A respondent had to (a) think of a value, (b) form a fraction of that value to the budgetary unit, (c) convert that fraction to the form 1/x, and (d) report x. Subjects given BU = $20 did not avoid this complexity. For items 2 through 7 (the items, we assert, for which $20 was most often outside the acceptable range for the vague translation of value into money), 38 percent of the BU = $20 responses were of this hardest type.

Thus, a critic of our interpretation would have to argue some sort of "semi-laziness." Such a tortuous explanation would have to explain why some groups were more "lazy" than others and why some items elicited more "lazy" responses than others. Our view of the data is far more parsimonious: There exists for each subject a wide range of money within which any particular dollar amount is deemed just as "correct" as any other to express the respondent's value for the good.

5.0 CONCLUSION

The results discussed in this paper add to the evidence that nonmarket environmental goods typically are not represented cognitively in monetary terms. When people are asked their monetary value for such a good, they must construct a value. This construction process opens the door to contextual effects that go well beyond traditional notions of bias. A successful valuation method should help respondents to think carefully and thoroughly about the nature of their preferences and provide assistance to help individuals structure and

monetize their environmental values. The results discussed here suggest that the search for improved techniques must come to terms with both the context dependency of contingent valuation results and the essential constructive nature of environmental values.

6.0 NOTES

The usual convention in doing a median test with one or more observations at the joint median is to group these observations with observations below the median. This convention leads to absurd results with the present data, because of the overwhelming popularity of the median response. For example, consider Item 7, BU = \$10 (mdn = \$10) vs. BU = \$20 (mdn = \$4). The joint median is \$10; the data are as follows:

	BU=10	BU=10	
Below mdn	22	31	53
At mdn	18	3	21
Above mdn	8	27	35
	48	61	109

By convention, the χ^2 for the median test is calculated on the data regrouped as follows:

	BU=10	BU=20	
At or below mdn	40	34	74
Above mdn	8	27	35
	48	61	109

The median test for these data is significant ($p < .005$), apparently establishing that a median of \$10 is significantly *smaller* than a median of \$4.

To avoid such absurdities, we assigned a proportionate number of the median observations to the categories "above" and "below," so that the marginal sums were equal. Thus for the data shown above, we regrouped by moving 1.5 of the 21 median observations

(7.1%) to the "below" category and the rest to the "above" category. After rounding to the nearest integer:

	BU=10	BU=20	
At or below mdn	23	31	54
At or above mdn	25	30	55
	48	61	109

The χ^2 test is not significant, as is appropriate for these data.

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Table 1. Proposed Environmental Projects

1. Planting daffodils in the median strip along I-5 between Salem and Eugene.
2. Protecting a 300-year-old Douglas Fir tree in downtown Salem.
3. Preserving the habitat of an endangered wild flower.
4. Winter feeding plan to help hungry Elk in the Three Sisters Wilderness area.
5. Funding to maintain roadside picnic areas in Oregon.
6. Funding an emergency rescue team to save beached whales along the Oregon coast.
7. Manual, rather than chemical, clearing of weeds alongside rural roads in Lane County.
8. Payments to help farmers decrease smoke emissions from field burning by 75 percent.
9. 50 percent reduction in the amount of chemical pesticides used on crops in Oregon.
10. Establishing protected zones around bald eagle nesting areas.
11. Enhancing streamside habitat for native fish like salmon and steelhead.
12. Planting 100,000 trees per year to help offset CO_2 emissions.

Note: The twelve items were not presented to subjects in the order shown in Table 1. Instead, the order for all subjects was 4, 1, 9, 2, 3, 12, 5, 10, 8, 7, 11, 6.

Table 2. Median Willingness to Pay in Dollars, All Items

	Budgetary Units				
	$1	$2	$5	$10	$20
Item					
1	.10	0.00	.05	0.00	0.00
2	.75	2.00	2.50	1.15	2.00
3	1.00	2.00	5.00	2.00	5.00
4	1.00	2.00	5.00	5.00	4.00
5	1.00	2.00	5.00	5.00	5.00
6	1.00	2.00	2.50	10.00	5.00
7	1.00	2.00	5.00	10.00	4.00
8	1.00	2.00	5.00	10.00	10.00
9	1.00	2.00	5.00	10.00	20.00
10	1.00	2.00	5.00	10.00	20.00
11	1.00	2.00	5.00	10.00	20.00
12	5.00	6.00	15.00	20.00	20.00

Table 3. Results of Median Tests

	Comparison of Forms with Different Budgetary Units									
Item	1v2	2v5	5v10	10v20	1v5	2v10	5v20	1v10	2v20	1v20
					Responses Translated to WTP					
2	*				**					*
3	**	***			***			*		***
4	*	***			***	***		**		**
5	*	*			***			**	**	***
6	***				*	*		***		**
7		*			**	*		**		**
8	**	***			***	*		***	**	***
9		**	*	***	*	***	***	***	***	***
10	*	***	*	**	***	***	***	***	***	***
11		***	*		***	**	**	**	***	***
12		*			**	**	**	***	***	***
					Raw, Untranslated Responses					
2							*		*	*
3			*				**	*	**	**
4				**			**		*	**
5										*
6		*							*	
7										
8							*			
9										
10								*		*
11										
12					*		**	**	*	***

* = $p \leq .05$
** = $p \leq .01$
*** = $p \leq .001$

Table 4. Comparison of BU=$1 and BU=$20 on Item 12

Raw Data

for BU=$ 1, Median = 5
for BU=$20, Median = 1
Joint Median = 2

Frequencies:

	BU=1	BU=20
below mdn	12	33
at mdn	3	9
above mdn	31	17
	46	59

Frequencies with median observations split proportionately:

	BU=1	BU=20
below mdn	14	39
above mdn	32	20

$\chi^2 = 13.15$
$p < .001$

Translated Data

for BU=$ 1, Median = $ 5.00
for BU=$20, Median = $20.00
Joint Median = $20.00

Frequencies:

	BU=1	BU=20
below mdn	37	10
at mdn	2	23
above mdn	7	26
	46	59

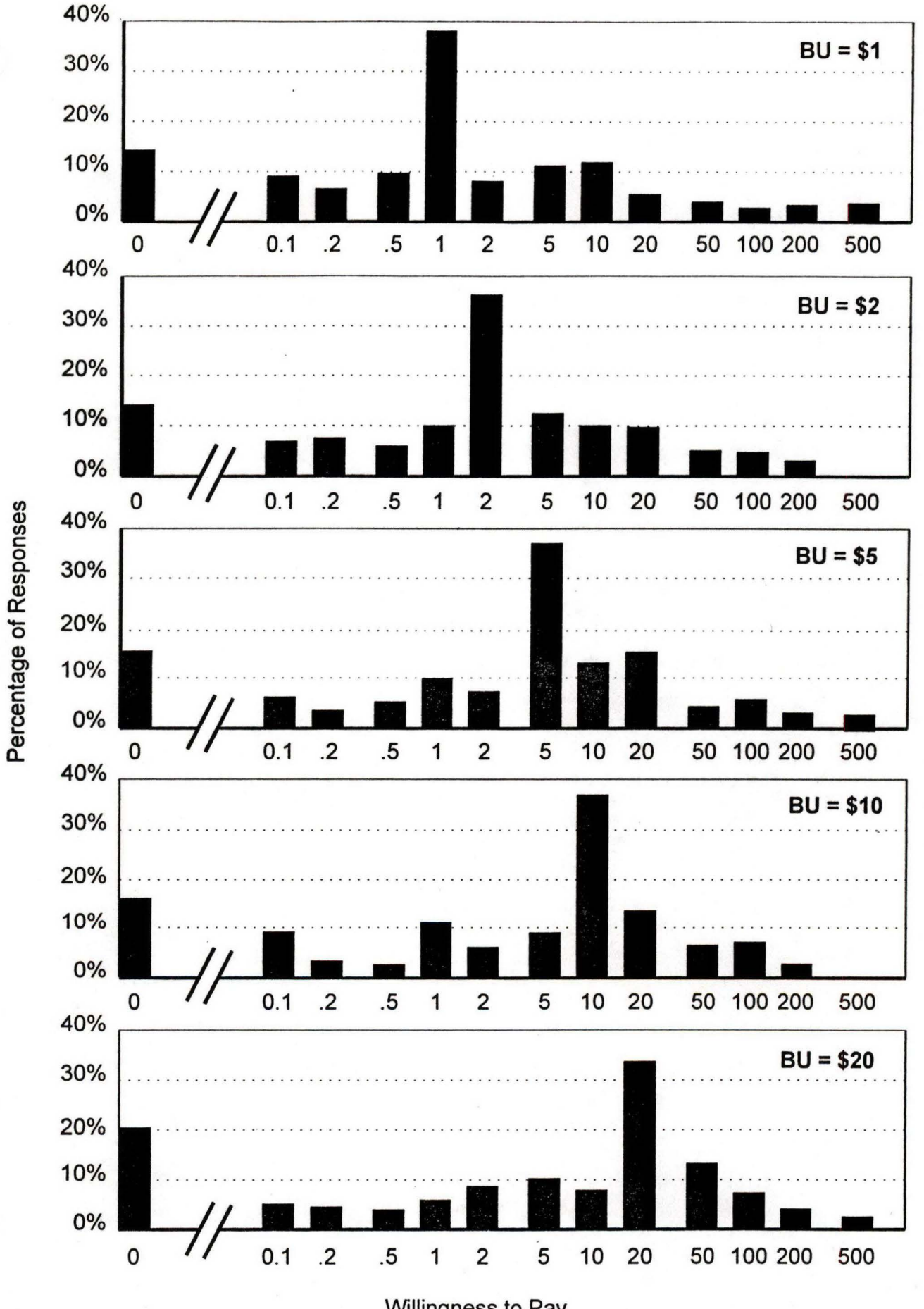
Frequencies with median observations split proportionately:

	BU=1	BU=20
below mdn	37	15
above mdn	9	44

$\chi^2 = 31.29$
$p < .001$

Figure Caption

Figure 1. Histograms of WTP responses (transformed) for all questions except Question 1. The responses are grouped in groups of equal width on a log scale and each bar is centered on the geometric mean of the responses in the group. The actual ranges of the responses were 0; .01-.10; .20-.25; .33-.50; 1.00-1.33; 1.67-3.00; 3.33-6.67; 7-12; 35-60; 70-125; 175-300; 375-2,500.


BU = $1
BU = $2
BU = $5
BU = $10
BU = $20
40%
30%
20%
10%
0%
0
0.1
.2
.5
1
2
5
10
20
50
100
200
500
Percentage of Responses
Willingness to Pay

Appendix A

Instructions for BU = $1

Decision makers often have a difficult time determining the value of natural resources. Values need to be determined when resources have been damaged due to a natural event (e.g., a severe winter storm) or a technological accident (e.g., an oil spill). Values also need to be determined when environmental improvements are considered, such as programs to improve air quality or to plant trees and improve habitat for animal species.

Listed on the following pages are brief descriptions of several types of possible activities that could be undertaken to protect or to enhance the environment of Oregon.

We'd like to know how much more you would be willing to spend each year, as part of the taxes and other payments you make to the State of Oregon, to undertake each of these projects. Consider the projects separately, as if only that one project were under consideration. When you are thinking about the additional payment you would make assume that other people would pay the same amount as part of their state payments.

To make the payment as realistic as possible, we want you to think about it in terms of a *BUDGETARY UNIT*. *BUDGETARY UNITS* are used by state legislators to plan out yearly expenditures and to decide among competing projects. Each *BUDGETARY UNIT* represents $1.

Please tell us, in terms of *BUDGETARY UNITS*, how much more money in taxes and other payments you would be willing to spend on each project. You can express your value for the project in one of four ways, as shown by the four columns A-D:

(1) If you believe that you do not want to pay anything at all, put an X in the left-hand column, column A.

(2) If your willingness to pay is equal to one *BUDGETARY UNIT*, put an X in the third column, column C.

(3) If your willingness to pay is more than one *BUDGETARY UNIT*, write a number greater than 1 in the right hand column, column D. This number is the number by which the budgetary unit must be multiplied to express your willingness to pay. For example, if your willingness to pay for a particular project is $100, the *BUDGETARY UNIT* would have to be multiplied by 100 to get $100 (because $1 multiplied by 100 equals $100). So for this example you would write "100" in column D.

(4) If your willingness to pay is less than one *BUDGETARY UNIT*, write a number greater than 1 in the second column, column B. This number is the number by which the budgetary unit must be divided to express your willingness to pay. For example, if your willingness to pay for a particular project is 10¢, the budgetary unit would have to be divided by 10 (because $1 divided by 10 equals 10¢). So for this example you would write "10" (not "$\frac{1}{10}$") in column B.

Remember to think about your willingness to pay, on an annual basis, to undertake each of the environmental projects described on the next pages. Remember also to consider each project separately, as if only that one were being considered.

[For the other forms, the multiplication example was always willingness to pay $100, with the multiplier changed as appropriate; the division example was always willingness to pay 10¢, with the divisor changed as appropriate.]